APPRENTICE CORE COMPETENCIES		NIMS CREDENTIALS
1.	Identify and Demonstrate Use of Machine Safety and Personal Protective Equipment	Measurement, Materials, and Safety Level I
2.	Demonstrate Compliance with Lock-out/Tag-out Procedures and OSHA Requirements and Guidelines	
3.	Machine Operations and Material Handling, Hazardous Materials Handling and Storage, including EPA, Hazmat, and OSHA	
4.	Part Inspection	
5.	Process Control	
6.	Process Adjustment – Single Part Production	
7.	Participation in Processes Improvement	
8.	Manual Operations: Layout	Job Planning, Benchwork, and Layout Level I
9.	Manual Operations: Benchwork	
10.	Sawing	
11.	Job Process Planning	
12.	Drilling Operations	Drill Press Skills Level I
13.	Turning Operations: Turning Between Centers	Turning Between Centers Level I
14.	Turning Operations: Turning Between Centers	Turning Between Centers Level II
15.	Turning Operations: Chucking	Chucking Level I
16.	Turning Operations: Chucking	Chucking Level II
17.	Milling: Square Up a Block	Milling Level I
18.	Manual Milling: Vertical and Horizontal	
19.	Manual Milling: Vertical and Horizontal	Milling Level II
20.	Surface Grinding, Grinding Wheel Safety	Grinding Level I
21.	Surface Grinding, Horizontal Spindle, Reciprocating Table	
22.	Surface Grinding, Horizontal Spindle, Reciprocating Table	Grinding Level II
23.	CNC Programming - Milling and / or CNC Programming - Turning	CNC Milling and / or CNC Turning Level I
24.	CNC: Write a Simple CNC Milling and / or CNC Turning Program and Review Tool Path	
25.	CNC: Operate a CNC Milling Machine and / or Operate a CNC Lathe	
26.	General Housekeeping & Maintenance	Included in all Machining Credentials
27.	Preventative Maintenance - Machine Tools	
28.	Tooling Maintenance	

***NOTE: There is not a specific sequence to the implementation of the Core Competencies. The twenty eight Core Competencies and the twelve NIMS Credentials, listed above, must be satisfactorily completed to meet the requirements of a NIMS Certified Apprentice Apprenticeship Program and earn a *Certificate of Completion*.**

10th of JANUARY 2005 NIMS CERTIFIED APPRENTICE CORE COMPETENCY REQUIREMENTS
DEVELOPED BY THE NIMS EXPERT PANEL

NIMS CREDENTIAL: Level I Machining Skills, Measurement, Materials, & Safety

---

Core Competency

1. Identify and Demonstrate Use of Machine Safety and Personal Protective Equipment

NIMS DUTY & PERFORMANCE STANDARD

Duty: Carry out assigned responsibilities while adhering to safe practices in accordance with Occupational Safety and Health Administration (OSHA) requirements and guidelines. Document safety activities as required. Include appropriate personal protective equipment.

Performance Standard: Given written and verbal safety instructions and checklists based on OSHA requirements and guidelines, demonstrate safe workplace practices in material handling, machine operations, handling of tooling, and handling and application of coolants, cutting fluids and lubricants. Orally explain the actions taken which directly or indirectly bear upon safe practice in the execution of assigned duties.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

Given instruction/demonstration and reading, and reviewing assignments, the apprentice will:

a. Identify areas in plant that require hearing devices and safety glasses.
b. Identify proper clothing required on the job to include shoes, gloves, sleeve and pant length, jewelry items, hair length, and personal cleanliness.
c. The apprentice will demonstrate OSHA lifting techniques, proper air gun usage and identification, and safe chip handling techniques.
d. The apprentice will identify all pinch points on primary and supportive machine tools and the proper placements of guards.
e. The apprentice will demonstrate both emergency and standard shut down of all required equipment.
f. The apprentice will demonstrate the proper use of hand tools to include hammer, wrenches, screwdrivers, punches and pliers.

Core Competency

2. Demonstrate Compliance with Lock-out and Tag-out Procedures and OSHA Requirements and Guidelines

NIMS DUTY & PERFORMANCE STANDARD

Duty: Carry out assigned responsibilities while adhering to safe practices in accordance with OSHA requirements and guidelines. Document safety activities as required.

Performance Standard: Given written and verbal safety instructions and checklists based on OSHA requirements and guidelines, demonstrate safe workplace practices in material handling, machine operations, handling of tooling, and handling and application of coolants, cutting fluids and lubricants. Orally explain the actions taken which directly or indirectly bear upon safe practice in the execution of assigned responsibilities.

NOTE

Lock-out/tag-out and right-to-know will be accounted for in Industrial Safety and Environmental Protection. Material handling here means handling of shafts and overhead cranes, etc., and personal protection. The apprentice should recognize pinch points, cutting points, and control points.

Core Competency

3. Machine Operations and Material Handling, Hazardous Materials Handling and Storage, including EPA, Hazmat, and OSHA

NIMS DUTY & PERFORMANCE STANDARD

Duty: Handle and store hazardous materials as assigned while adhering to safe practices in accordance with OSHA and EPA requirements and guidelines. Document safety activities as required.

Performance Standard: Given written and verbal safety instructions detailing the handling and storage of hazardous materials in compliance with OSHA and EPA requirements and guidelines, demonstrate safe workplace practices in the identification, handling, and storage of hazardous materials.

Core Competency

4. Part Inspection

NIMS DUTY & PERFORMANCE STANDARD

Duty: Develop an inspection plan and inspect simple parts using precision tools and techniques. Prepare reports on the compliance of the parts.

Performance Standard: Given the necessary job process sheets for a part and verbal instructions, identify and select the required measuring instruments and conduct the required inspection procedure(s). Complete required written inspection report and make a decision to accept or reject component parts. Provide brief verbal explanation of inspection procedures, results, and decisions.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently)

Verify calibrations and sizes of all measuring devices. Take measurements to an accuracy of 1/64 for fractions, .002 for decimals and ½ degree for angles. Read standard orthographic prints and understand types of lines, title block information, revision levels, abbreviations, symbols, and tolerances. Identify surface defects, burrs and any adverse conditions such as flat or torn threads, out of round conditions, eccentricity, etc.

Core Competency

5. Process Control

NIMS DUTY & PERFORMANCE STANDARD

Duty: Follow a sampling plan. Inspect the samples for the required data. Enter the data on appropriate charts. Graph the data. Respond to the warning conditions indicated by the process charts.

Performance Standard: Given the necessary job process sheets for a part, verbal instructions, and the necessary charts and inspection tools, inspect parts according to the sampling plan, collecting the data required for the process control chart. Working with the supplied control and warning limits, place the data, produce new data as needed, graph the data, and take the Stop or Go actions as indicated by the results of producing the process control chart. Provide brief verbal explanation regarding the decision taken.

Core Competency

6. Process Adjustment—Single Part Production

NIMS DUTY & PERFORMANCE STANDARD

Duty: Analyze the performance of a single-part production process. Formulate process adjustments or improvements where appropriate. Where appropriate, notify supervision of the proposed adjustment and/or improvement. Where authorized, carry out the strategies for process adjustment and/or improvement.

Performance Standard: Given a process plan, part print, inspection process plan, verbal instructions, the necessary tools and equipment, and a part having routine problems being processed, analyze the problem(s), propose a remedy(ies), having been given authorization to implement the process improvement(s), carry it out. Explain the corrective actions and the reasoning used to perform the diagnosis.

Core Competency

7. Participation in Process Improvement

NIMS DUTY & PERFORMANCE STANDARD

Duty: As a member of a process team, analyze the performance of a production process. With the team formulate process adjustments or improvements where appropriate. Where appropriate, notify supervision of the proposed adjustments and/or improvement. Where authorized, carry out the strategies for process adjustment and/or improvement.

Performance Standard: Given a process plan, part print, inspection process plan, verbal instructions, the necessary tools and equipment, and a routine production process having a problem(s), as a team member, analyze the problem(s), propose a remedy(ies), having been given authorization to implement the process improvement(s), carry it out. Carry out the cause and effect analysis by participating in the development of the appropriate Q.C. methodology with the team, i.e., fishbone diagram. Explain the Q.C. tool, the corrective actions and the reasoning connecting the root cause analysis to the remedial actions taken.

Related Instruction

The knowledge and skills the apprentice will need to pass the ***Level I Machining Skills, Measurement, Materials, and Safety*** credentialing exam are as follows:

Applying the *Machinery's Handbook*: The apprentice must be able to reference and apply information found in the handbook to solve application problems. Referencing thread percentage, finish symbols, and allowances are some of the skills required.

Basic Mathematics: The exam will assess basic math knowledge of fraction/decimal conversion, addition and subtraction of decimals, and an understanding of percent.

Industrial Safety: The apprentice must become familiar with Hazmat, MSDS, basic personal protective equipment (PPE), and machine tool safety. Student assessment includes identification of a government body that regulates industrial safety – Occupational Safety and Health Administration (OSHA).

Maintenance: Student assessment includes elementary knowledge of referencing and researching maintenance procedures, hand tool maintenance and safety, and simple tool maintenance.

Process Adjustment: The exam presents basic problems of machining processes such as tapping, threading, drilling, milling, reaming, and grinding in which a process adjustment functions as the corrective action. Students must identify a basic goal of process improvement.

Quality Control Procedures: The exam will evaluate knowledge of basic concepts of SPC and sampling plans. Basic knowledge of inspection plans includes rationale, criteria for choosing the correct measuring instrument, and organization. The evaluation includes basic knowledge of inspection setups and measuring instruments.

NIMS CREDENTIAL: Level I Machining Skills, Job Planning, Benchwork, and Layout

---

Core Competency

8. Manual Operations: Layout

NIMS DUTY & PERFORMANCE STANDARD

Duty: Layout the location of hole centers and surfaces within an accuracy of +/-.015 inch.

Performance Standard: Given a surface plate, surface gauge, layout height gauge, combination set, scriber, layout ink, prick punch, ball peen hammer, process plan, and part print, layout hole locations, radii, and surfaces matching the specifications.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

a. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge and understanding of blueprint reading, and understand orthographic projections in order to perform all machining tasks.

b. Given a part print, surface plate and all the required layout tools, the apprentice will select proper tools, and use correct procedure, to layout a part including the location of hole centers and surfaces within the accuracy of +/- .015 inch.

Core Competency

9. Manual Operations: Benchwork

NIMS DUTY & PERFORMANCE STANDARD

Duty: Using aluminum or mild steel, hand drill and hand tap holes. Use hand drills, hand taps, tap wrench, files, scrapers, and coated abrasives to deburr parts. Use arbor presses to perform press fits. Use bench vises and hand tools appropriately.

Performance Standard: Given a process plan, blueprint, and access to hand tools, produce a part with two holes prepared for hand tapping, a hole prepared (reamed) for the press fit of a bushing, and a stud for one of the tapped holes. Deburr the part, hand drill and hand tap the holes, press in the bushing, and install the stud.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

a. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge and understanding of blueprint reading, and understand orthographic projections in order to perform all machining tasks.

b. Given a part print, surface plate and all the required layout tools, the apprentice will select proper tools, and use correct procedure, to layout a part including the location of hole centers and surfaces within the accuracy of +/- .015 inch.

c. Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will select the correct tap drills to achieve a minimum of 75% thread in the required tapped holes, and the correct pre-drill hole for reaming operations to achieve tolerances specified on the part print.

d. Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will calculate cutting speeds required to perform benchwork-machining operations.

e. Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will calculate dimensions required for a press fit, and use an arbor to perform press fit operations.

f. Given instruction/demonstration on the procedure used for hand filing, drilling, and reaming, the apprentice will perform filing, drilling, and reaming operations within the specified tolerances on the part print.

g. Given instruction/demonstration on the proper tap selection and the procedure used for hand tapping, the apprentice will perform tapping operations within the specified tolerances on the part print.

Core Competency

10. Sawing

NIMS DUTY & PERFORMANCE STANDARD

Duty: Set-up and perform sawing to a layout. Choose and mount appropriate blades; weld, break, and re-weld blades as necessary.

Performance Standards: Given a part with a finished layout and access to an appropriate bandsaw and blades, finish saw the part to the layout.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

a. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge of bandsaw safety procedures, and the identification of bandsaw parts and their function.

b. Given instruction/demonstration on the proper selection, mounting, set-up, and usage procedure for necessary work-holding devices on the bandsaw, the apprentice will select, mount, set-up, hold, and align work using work holding devices on the bandsaw to perform the required sawing operations.

c. Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will choose the correct blade for specific sawing operations, and calculate cutting speeds and apply these calculations while performing required sawing operations on the bandsaw.

d. Given instruction/demonstration, reading assignment, and the correct bandsaw blade material to perform a specific sawing operation, the apprentice will properly weld and mount the finished blade on the bandsaw.

e. Given a bandsaw, process plan, part print, part with finished layout, bandsaw blade, hand tools, bandsaw accessories, instruction/demonstration on the proper set-up, and procedures used for sawing, the apprentice will perform the sawing operations on the part according to the layout specified on the part print.

Core Competency

11. Job Process Planning

NIMS DUTY & PERFORMANCE STANDARD

Duty: Develop a process plan for a part requiring milling, drilling, turning, or grinding. Fill out an operation sheet detailing the process plan and required speeds and feeds.

Performance Standard: Given a print detailing a part requiring milling, drilling, turning, and grinding, verbal instructions, and appropriate references, formulate a set of strategies to manufacture the part and fill out an operation sheet reflecting the chosen strategies including the required speeds and feeds.

Identify all major components and functions of the machine tools, and all major hand tools, measuring tools, tools and fixtures, and work materials. Provide the rationale for the speeds and feeds selected.

PERFORMANCE OBJECTIVES: +/ (What an apprentice must know and/or do to perform the work competently.)

a. The apprentice will be able to choose the most appropriate location for the origin on the part, and establish a method for defining that location during set-up.
b. The apprentice will be able to select appropriate work holding devices for various work pieces.
c. The apprentice will be able to select appropriate tooling and tool holders for various operations and materials.
d. The apprentice will be able to calculate speeds and feeds for proper tool-life and surface finish.

Related Instruction

The knowledge and skills you will need to pass the ***Level I Machining Skills, Job Planning, Benchwork, and Layout*** credentialing exam are as follows:

Basic Mathematics: The exam will assess basic math knowledge from whole number computations and algebra to basic geometry. Application of formulas involving tapping, tapers, speeds and feeds and threading will be evaluated.

Applying the *Machinery's Handbook*: The apprentice must be able to reference and apply information found in the handbook to solve application problems. Referencing limits, tolerance, and parameters of a material or process are essential skills.

Basic Measurement: The exam will test interpretation of basic measuring instruments, resolution, and applicability of basic measuring tools for given situations. Students must demonstrate knowledge of the differences and similarities of semi-precision and precision measurement.

Basic Machining Theory: The apprentice must understand basic types of tooling materials, applications of tooling and processes for drilling, milling, and sawing, turning, and proper procedures using hand tools. A basic understanding of fits and allowances, as well as defining surface finish and machining operation/surface finish relationships, is expected.

Layout: The exam will evaluate an understanding of basic and precision layout equipment and procedures. The apprentice should have a basic knowledge of print reading and orthographic projection. Knowledge of the layout of linear, angular, and circular dimensions will be assessed.

NIMS CREDENTIAL: Level I Machining Skills, Drill Press Skills

---

Core Competency

12. Drilling Operations

NIMS DUTY & PERFORMANCE STANDARD

Duty: Set-up and operate machine tools to perform routine drilling operations.

Performance Standard: Given a semi-finished part, process plan, part print, and hand precision, and cutting tools, as well as access to a drill press and its accessories, produce a part matching the process plan and the blueprint specifications. The part specified will be in the semi-finished state, having been squared up and the outer surfaces completed with five center-drilled locations. Finishing the part will require the finishing of the five center-drilled locations. Each hole must have at least two secondary operations. The secondary operations will consist of reaming, spot facing, countersinking, counterboring, and counterdrilling. At least one hole must be a blind hole and one a through hole. At least one hole will be power tapped.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

a. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge of drill press safety procedures, and the identification of drill press and radial drill press parts and their function.

b. Given instruction/demonstration on the proper selection, mounting, set-up, and usage procedure for necessary work-holding devices on the drill press, the apprentice will select, mount, set-up, hold, and align work using work holding devices on the drill press to perform the required drill press operations.

c. Given instruction/demonstration on the proper selection, mounting, set-up, and usage procedure for necessary tool-holding devices on the drill press, the apprentice will select, mount, set-up, and align tool-holding devices on the drill press to perform the required drill press operations.

d. Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will calculate cutting speeds and feeds and apply these calculations while performing required machining operations on the drill press.

e. Given a drill press, process plan, part print, semi-finished part, cutting tools, hand tools, drill press accessories, and instruction/demonstration on the proper set-up and procedures used for drilling, tapping, reaming, spot facing, countersinking, and counterboring, the apprentice will perform these secondary operations on the semi-finished part to within the tolerances specified on the part print.

Related Instruction

The knowledge and skills you will need to pass the ***Level I Machining Skills, Drill Press Skills*** credentialing exam are as follows:

Drill Press Components: Proper operation of a drill press depends on knowledge of drill press components and their functions. Identification of the spindle, base, table, column, variable speed control, and feed handle are essential for safe and effective use of this machine tool. Other essential components are the table lock, column lock, motor, and base.

Process Involvement: An important part of any process improvement is an understanding of the symptoms and causes of some common problems associated with drilling operations. Understanding root causes of drill breakage, excessive wear, enlarged diameters, and excessive RPM enable the apprentice to analyze the process and make the correct improvement.

Twist Drill Nomenclature and Sizing: Each twist drill is comprised of many separate features. Identifying the web and understanding web thickness enables the apprentice to recognize the effects of excessive web thickness. Knowing the purpose and location of the margin facilitates proper drill diameter measurement as well as the effect of worn margin near the point of the drill. All general-purpose drills have the same identical point angle. The included point angle of a drill will vary dependent on the application and the material being machined.

Safety Practices: Proper safety procedures insure safe and productive machining. Safety includes safe lifting procedures, hair containment, jewelry removal, and loose clothing containment. Drill press safety includes the proper location of the vise, storage of the chuck key, and chip removal. Safety awareness should be apparent at all times through the correct application of speeds and feeds.

Countersinking, Counterboring, Spotfacing, and Center Drilling: Spotfacing, countersinking, and counterboring are drilling procedures used to seat screws and bolts with special head configurations or to seat a fastener or washer evenly on a rough surface. Center drilling is an important procedure for accurate hole location as well as shaft preparation for turning between centers. The specific drilling operations have speeds and feeds that are proportionally slower than drilling with general-purpose twist drills.

Layout and Inspection: Choosing the correct measuring instrument is primarily dependent on the tolerance range of the specific dimension. Proper set-up and correct measuring procedures for each measuring device are critical. The apprentice must also know when and where to apply semi-precision and precision layout. Selection and application of proper layout tools and setups are essential in any machining operation.

Tapping: The drill diameter used to create a hole for internal threading will dictate the thread percentage or amount of engagement between two mating threaded components. Most tap drill charts for conventional thread forms are based on 70% – 75% engagement. Pipe taps used for some pneumatic and fluid connects have tap drills based on other parameters. With the proper equipment, tapping can be performed under power if the drill press is capable of reversing the rotation.

Work Holding: The work piece must be held securely to prevent part pullout from the work holding device. The equipment used for work holding parts is dependent upon the shape and size of the part being drilled. Proper location of the vise may prevent the vise from whipping around if the drill gets jammed in the part. Proper selection of work holding devices is critical for safe and accurate application of a drill press.

NIMS CREDENTIALS: Levels I and II Machining Skills, Turning Operations, Turning Between Centers

---

Core Competency

13. Turning Operations: Turning Between Centers, Level I Machining Skills
NIMS DUTY & PERFORMANCE STANDARD

Duty: Set-up and carry out between centers turning operations for straight turning.

Performance Standard: Given raw material, process plan, part print, and hand, precision, and cutting tools, as well as access to an appropriate turning machine and its accessories, produce a part matching the process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least three diameters within +/-.002 inch, one UNC external thread, one UNF external thread, and require an end-for-end swap.

Core Competency

14. Turning Operations: Turning Between Centers, Level II Machining Skills

NIMS DUTY & PERFORMANCE STANDARD

Duty: Set-up and perform between centers turning for straight and tapered turning by offsetting the tailstock.

Performance Standard: Given raw material, process plan, part print, and hand, precision, and cutting tools, as well as access to an appropriate turning machine and its accessories, produce a part matching the process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least two straight diameters within +/-.001 inch, an appropriate taper at each end of the part, and requires an end-for-end reversal of the part.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

a. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge of engine lathe safety procedures, and the identification of engine lathe parts and their function.

b. Given instruction/demonstration by a qualified individual on cutting tool geometry and the proper procedure used for grinding lathe tool bits on the off-hand grinder, the apprentice will perform grinding operations and produce all the required tool bits necessary to perform all required turning operations within the specified tolerances on a part print.

c. Given instruction/demonstration on cutting tool geometry and inserted tooling, the apprentice will demonstrate the proper insert and tool holder selection, necessary to perform all required turning operations within the specified tolerances on a blueprint.

d. Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will calculate cutting speeds and feeds and apply these calculations while performing required various turning operations on the engine lathe.

e. Given instruction/demonstration on the proper selection, mounting, set-up, and usage procedure for the four specified work-holding devices (3-jaw chuck, 4-jaw chuck, face plate and dog, and draw-in collet chuck), the apprentice will select, mount, set-up, hold, and align work using work holding devices on the engine lathe to perform the required turning operations.

f. Given instruction/demonstration on the proper set-up and procedures used for drilling and center drilling on the engine lathe, the apprentice will perform drilling and center drilling operations within the tolerances specified on a part print.

g. Given instruction/demonstration on the proper procedure used for turning, facing, necking, and grooving operations on the engine lathe, the apprentice will perform turning, facing, necking, and grooving operations within the specified tolerances on the part print.

h. Given instruction/demonstration on the proper procedure used for performing shouldering operations on the engine lathe, the apprentice will perform square, angular, and filleted shouldering operations within the tolerances specified on a part print.

i. Given instruction/demonstration on the proper set-up procedure used for knurling on the engine lathe, the apprentice will set-up the machine and perform knurling operations within the tolerances specified on the part print.

j. Given instruction/demonstration on Unified National Thread nomenclature, formulas and the proper set-up procedure used for cutting threads on the engine lathe, the apprentice will cut an external U.N. thread within the tolerances specified on the part print.

k. Given a blueprint, instruction/demonstration on taper calculations, and the proper set-up procedure used for cutting internal and external tapers on the engine lathe, the apprentice will cut a taper on the engine lathe using the tailstock set-over method, compound rest, and a taper attachment to within the tolerances specified on a part print.

Related Instruction

The knowledge and skills you will need to pass the ***Turning Operations: Turning Between Centers, Level I Machining Skills*** and ***Turning Operations: Turning Between Centers, Level II Machining Skills*** credentialing exams are as follows:

Process Improvement and Troubleshooting: To improve a process, one must first understand the process. A competent apprentice should be able to identify the root cause if a straight cut between centers measures as a taper. Measuring a taper (when a straight cut is intended) and moving the tailstock the proper amount based on the measurement is another skill needed to effectively and efficiently engage in turning operations. Other skill sets include the proper way to take the first cut on cast iron and hot roll steel, the root cause of lathe center run out, properly turning hard material, and the effect of having the lathe tool above or below center.

Turning Safety: Safety knowledge and practice is an important component for lathe operations. The apprentice must know the basic personal protective equipment needed to operate a lathe safely and effectively. Proper lifting techniques, learning how to find MSDS and HMIS information, and some basic personal first-aid are essential knowledge for all apprentices. Other safety components involve the safe installation of chucks and collets as well as chip control and chip removal.

Lathe Controls: An understanding of basic lathe control mechanisms enables the apprentice to utilize the lathe in an efficient and productive manner. Knowing how each control works and its function is critical to any safe turning operation. Knowing how to use the feed reverse lever, half nut lever, and the proper method to change speeds and feeds is also critical knowledge. Each manufacturer of lathes has unique methods of implementing lathe controls. It is the job of the apprentice to become familiar with each particular set of lathe controls.

Single Point Threading: Single point threading is one of the fundamental skill sets needed to operate a lathe. The apprentice must be familiar with thread angles, helix angles, thread pitch diameter, lead, and different families of thread forms. Proper alignments of the threading tool, as well as the proper location of the compound rest, are essential set-up steps needed to turn threads with a single point tool. An apprentice must be able to calculate the proper in feed to prevent the thread from either being too deep or too shallow.

Tapping, Fits, and Allowances: The turning process is often used to size shafts and holes for certain fits. Knowledge of the definitions of a fit and an allowance is essential prior to machining. The apprentice should have a basic knowledge of the types of fits and be able to reference the *Machinery's Handbook* to determine the size of the each component. Planning the sequence of operations is essential to prevent ruining a fit due to burrs and poor surface finish.

Measurement: The best choice depends on the accuracy and reliability of the measuring instrument. Tolerance as well as the application will also be important factors. An apprentice must also know how to read the measuring instrument properly. An example would be comparing a depth micrometer, outside micrometer, and a dial indicator. Thread measurement and surface finish are also important factors when measuring features produced by the turning process.

Process Control: Monitoring the process with process control techniques results in quality parts and customer satisfaction. The first step in any process control endeavor is knowing when the part is accepted or rejected. Basic knowledge of process control techniques such as inspection sheets, Pareto charts, capability studies and X bar/R charts are an effective means of process control. The most common method of process control, besides the inspection sheet, is SPC (statistical process control) utilizing the X bar/R chart. The apprentice must understand the definition of range, mean, upper control limit, lower control limit, and sample size.

Tooling and Lathe Set-up: Many lathe applications use tooling with carbide inserts. However, some lathe applications use high-speed steel tools that must be ground to the desired shape. The apprentice should know the proper sequence for grinding the surfaces of the lathe tool applying the proper rake angles. Knowledge of the various methods of aligning the lathe centers and the degree of accuracy of each method depends on the tolerance of the work piece dimensions. Proper setups for facing and compound rest fundamentals are other essential skill sets included in this area.

Layout Procedures: Layout is the initial step in any machining process. Understanding the concepts and proper utilization of semi-precision and precision layout techniques is important for every apprentice. The apprentice should know the function of a scriber and the types of layout instruments used with surface plates.

NIMS Credentials: Levels I and II Machining Skills, Turning Operations: Chucking

---

Core Competency

15. Turning Operations: Chucking: Level I Machining Skills

NIMS DUTY & PERFORMANCE STANDARDS

Duty: Set-up and carry out chucking operations for turning.

Standard: Given raw material, process plan, part print, and hand, precision and cutting tools, as well as access to an appropriate turning machine and its accessories, produce a part matching the process plan and the print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least three diameters within +/-.005 inch, two bores within +/-.005 inch, one UNC external thread, and require at least two chuckings or other work holding set-up.

Core Competency

16. Turning Operations: Chucking: Level II Machining Skills

NIMS DUTY & PERFORMANCE STANDARDS

Duty: Set-up and perform tapered boring and turning using a taper attachment.

Standard: Given raw material, process plan, part print, and hand, precision, and cutting tools, as well as access to an appropriate turning machine with a taper attachment and its accessories, produce a part matching the process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least two diameters within +/-.002 inch, one bore within +/-.002 inch, one external and one internal taper, and requires at least two chuckings or other work holding set-up.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

a. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge of engine lathe safety procedures, and the identification of engine lathe parts and their function.

b. Given instruction/demonstration on cutting tool geometry and the proper procedure used for grinding lathe tool bits on the off-hand grinder by a qualified individual, the apprentice will perform grinding operations and produce all the required tool bits necessary to perform all required turning and boring operations within the specified tolerances on a part print.

c. Given instruction/demonstration on cutting tool geometry and inserted tooling, the apprentice will demonstrate the proper insert and tool holder selection necessary to perform all required turning and boring operations within the specified tolerances on a part print.

d. Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will calculate cutting speeds and feeds and apply these calculations while performing various required turning operations on the engine lathe.

e. Given instruction/demonstration on the proper selection, mounting, set-up, and usage procedure for the four specified work-holding devices (3-jaw chuck, 4-jaw chuck, face plate and dog, and draw-in collet chuck), the apprentice will select, mount, set-up, hold, and align work using work holding devices on the engine lathe to perform the required turning operations.

f. Given instruction/demonstration on the proper set-up and procedures used for drilling and center drilling on the engine lathe, the apprentice will perform drilling and center drilling operations within the tolerances specified on a part print.

g. Given instruction/demonstration on the proper procedure used for turning, facing, necking, and grooving operations on the engine lathe, the apprentice will perform turning, facing, necking, boring, and grooving operations within the specified tolerances on the part print.

h. Given instruction/demonstration on the proper procedure used for performing shouldering operations on the engine lathe, the apprentice will perform square, angular, and filleted shouldering operations within the tolerances specified on a part print.

i. Given instruction/demonstration on Unified National Thread nomenclature, formulas, and the proper set-up procedure used for cutting threads on the engine lathe, the apprentice will cut an external and internal U.N. thread within the tolerances specified on the part print.

j. Given a blueprint, instruction/demonstration on taper calculations, and the proper set-up procedure used for cutting tapers on the engine lathe, the apprentice will cut an external and internal taper on the engine lathe using the tailstock set-over method, compound rest, and a taper attachment to within the tolerances specified on a part print.

Related Instruction

The knowledge and skills you will need to pass the ***Turning Operations: Chucking, Level I Machining Skills*** and ***Turning Operations: Chucking, Level II Machining Skills*** credentialing exams are as follows:

Process Improvement and Troubleshooting: To improve a process, one must first understand the process. A competent apprentice should be able to identify the root cause if a straight cut between centers measures as a taper. Measuring a taper (when a straight cut is intended) and moving the tailstock the proper amount based on the measurement is another skill needed to effectively and efficiently engage in turning operations. Other skill sets include the proper way to take the first cut on cast iron and hot roll steel, the root cause of lathe center run out, properly turning hard material, and the effect of having the lathe tool above or below center.

Turning Safety: Safety knowledge and practice is an important component for lathe operations. The apprentice must know the basic personal protective equipment needed to effectively operate a lathe safely. Proper lifting techniques, learning how to find MSDS and HMIS information, and some basic personal first-aid are essential knowledge for all apprentices. Other safety components involve the safe installation of chucks and collets as well as chip control and chip removal.

Lathe Controls: An understanding of basic lathe control mechanisms enables the apprentice to utilize the lathe in an efficient and productive manner. Knowing how each control works and its function is imperative to any safe turning operation. Knowing how to use the feed reverse lever, half nut lever, and the proper method to change speeds and feeds is imperative knowledge. Each manufacturer of lathes has unique methods of implementing lathe controls. It is the job of the apprentice to become familiar with each particular set of lathe controls.

Single Point Threading: Single point threading is one of the fundamental skill sets needed to operate a lathe. The apprentice must be familiar with thread angles, helix angles, thread pitch diameter, lead, and different families of thread forms. Proper alignment of the threading tool as well as the proper location of the compound rest is essential set-up steps needed to turn threads with a single point tool. An apprentice must be able to calculate the proper infeed to prevent the thread from either being cut too deep or too shallow.

Tapping, Fits and Allowances: The turning process is often used to size shafts and holes for certain fits. Knowledge of the definitions of a fit and an allowance is essential prior to machining. The apprentice should have a basic knowledge of the types of fits and be able to reference the *Machinery's Handbook* to determine the size of each component. Planning the sequence of operations is essential to prevent ruining a fit due to burrs and poor surface finish.

Measurement: Choosing the proper measuring instrument is an important facet of proper inspection. The best choice is dependent on the accuracy and reliability of the measuring instrument. The tolerance as well as the application will determine the choice. An apprentice must also know how to read the measuring instrument properly. An example would be comparing a depth micrometer, outside micrometer, and a dial indicator. Thread measurement and surface finish are also important factors when measuring features produced by the turning process.

Process Control: Monitoring the process with process control techniques results in quality parts and customer satisfaction. The first step in any process control endeavor is knowing when the part is accepted or rejected. Basic knowledge of process control techniques, such as inspection sheets, Pareto charts, capability studies and X bar/R charts are an effective means of process control. The most common method of process control, besides the inspection sheet, is SPC (statistical process control) utilizing the X bar/R chart. The apprentice must understand the definition of range, mean, upper control limit, lower control limit, and sample size.

Tooling and Lathe Set-up: Many lathe applications use tooling with carbide inserts. However, some lathe applications use high-speed steel tools that must be ground to the desired shape. The apprentice should know the proper sequence for grinding the surfaces of the lathe tool by applying the proper rake angles. Knowledge of the various methods of aligning the lathe centers and the degree of accuracy of each method depends on the tolerance of the work piece dimensions. Proper setups for facing and compound rest fundamentals are other essential skill sets included in this area.

Layout Procedures: Layout is the initial step in any machining process. Understanding the concepts and proper utilization of semi-precision and precision layout techniques is important for every apprentice. The apprentice should know the function of a scriber and the types of layout instruments used with surface plates.

NIMS CREDENTIAL: Level I Machining Skills, Milling: Square Up a Block

---

Core Competency

17. Milling: Square Up a Block

NIMS DUTY & PERFORMANCE STANDARD

Duty: Set-up and perform squaring up the six surfaces of a block to within +/-.002 inch and .002 inch over 4.5 inches squareness.

Performance Standard: Given raw material, process plan, part print, and hand, precision, and cutting tools, as well as access to an appropriate milling machine and its accessories, produce a part matching the process plan and the part print specifications. The part will require squaring up from its raw state.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

a. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge of milling machine safety procedures, as well as the identification of milling machine parts and their function.

b. Given instruction/demonstration on cutting tool geometry for High Speed Steel milling cutters, the apprentice will perform proper cutting tool selection necessary to perform all required milling operations within the specified tolerances on a part print.

c. Given instruction/demonstration on cutting tool geometry and inserted tooling, the apprentice will demonstrate the proper insert and tool holder selection necessary to perform all required milling operations within the specified tolerances on a blueprint.

d. Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will calculate cutting speeds and feeds and apply these calculations while performing required milling operations on the milling machine.

e. Given instruction/demonstration on the proper selection, mounting, set-up, usage procedure for work-holding devices, and an understanding of climb and conventional milling, the apprentice will select, mount, set-up, hold, and align work using work holding devices on the milling machine to perform the required milling and squaring operations.

f. Given instruction/demonstration on the proper set-up and procedures used to perform the squaring up operation, the apprentice will square up six primary surfaces of a raw cut block within the tolerance of ± .002 inch maintaining parallelism and perpendicularity measurement with a TIR of .002 inch over 4.5 inches.

Related Instruction

The knowledge and skills you will need to pass Milling***: Square Up a Block, Level I Machining Skills*** credentialing exam are as follows:

Applying the *Machinery's Handbook*: The apprentice must be able to reference and to apply information found in the handbook to solve applied problems. Referencing thread percentage, tap drill diameters, speeds, feeds, and cutting tool parameters are some of the skills required.

Basic Mathematics: The exam will assess basic math knowledge of fraction/decimal conversion, addition and subtraction of decimals, and an understanding of percentage. Processing basic formulas to solve for the given known or another part of the formula is an additional skill required for this module.

Vertical Milling Machine Components: The exam presents questions asking the student to identify components of vertical milling machines. Apprentices must be able to identify essential components, their functions and basic machine adjustments.

Threads and Tapping: Specific areas of knowledge include an understanding of tap drill charts and thread percentage, tapping lubricants, tap drills for pipe threads, and taps used for specific operations. The apprentice must be able to troubleshoot basic tapping and threading problems.

Safety Practices: Areas of knowledge includes knowledge of basic safety, cutting tool safety, and basic machine maintenance and housekeeping. Apprentices must know some elementary first-aid procedures they can perform on themselves.

Milling Operations Set-up: The apprentice must know the procedure for adjusting the mill head to be perpendicular to the table (tramming). Other areas of importance include centering various details or shapes and the proper procedure for utilizing center-finding tools. The importance of layout lines and machining to the lines as well as the application of the sine bar are included within milling operations set-up.

NIMS CREDENTIALS: Levels I and II Machining Skills, Manual Milling Skills

---

Core Competency

18. Manual Milling: Vertical and Horizontal, Level I Machining Skills

NIMS DUTY & PERFORMANCE STANDARD

Duty: Vertical Milling

Set-up and operate vertical milling machines. Perform routine milling and locate hole centers within +/-.005 inch.

Performance Standard: Vertical Milling

Given raw material, process plan, print, and hand, precision, and cutting tools, as well as access to an appropriate vertical milling machine and its accessories, produce a part matching the process plan and the blueprint specifications using appropriate trade techniques and speeds and feeds. The part specified should require squaring up from the raw state, have at least one milled slot, require the location of at least two drilled and reamed holes within +/- .005 inch, and have three steps controlled by tolerances of +/-.005 inch.

Core Competency

19. Manual Milling: Vertical and Horizontal, Level II Machining Skills

NIMS DUTIES & PERFORMANCE STANDARDS

Duty: Vertical Mill - Precision Location of Holes

Set-up and perform boring for location, size, and finish.

Performance Standard: Vertical Mill - Precision Location of Holes

Produce three bores to specification. The holes will be between ¾ inch and 1-1/2 inches and their locations are to be held within +/-.001 inch and diameters within +/-.0005 inch. One hole is to be counterbored to a decimal depth holding within +/-.002 inch and counterbore diameter within +/-.005 inch.

Duty: Milling Keyseats

Set-up and perform milling keyseats on a shaft.

Performance Standard: Milling Keyseats

Given raw material, process plan, part print, and hand, precision, and cutting tools, as well as access to an appropriate milling machine and its accessories, produce a part matching the process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified will require milling two keyseats whose characteristics match the ANSI B17.1 keys and keyseat standards.

Duty: Milling - Cut a Deep Slot

Set-up and perform the cutting of a deep slot.

Performance Standard: Milling - Cut a Deep Slot

Given raw material, process plan, part print, and hand, precision, and cutting tools, as well as access to an appropriate milling machine and its accessories, produce a part matching the process plan and the part print specifications. The part specified will require the milling of three deep slots-two parallel to one another, the third at right angles to the first two.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

a. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge of milling machine safety procedures, and the identification of milling machine parts and their function.

b. Given instruction/demonstration on cutting tool geometry for High Speed Steel milling cutters, the apprentice will perform proper cutting tool selection necessary to perform all required milling operations within the specified tolerances on a part print.

c. Given instruction/demonstration on cutting tool geometry and inserted tooling, the apprentice will demonstrate the proper insert and tool holder selection necessary to perform all required milling operations within the specified tolerances on a blueprint.

d. Given instruction/demonstration, reading assignment, information sheets, and reference charts, the apprentice will calculate cutting speeds and feeds and apply these calculations while performing required milling, drilling, and boring operations on the milling machine.

e. Given instruction/demonstration on the proper selection, mounting, set-up, usage procedure for work-holding devices, and an understanding of climb and conventional milling, the apprentice will select, mount, set-up, hold, and align work

using work holding devices on the milling machine to perform the required milling and squaring operations.

f. Given required hand and precision tools, instruction/demonstration on the proper set-up and procedures used to perform tramming operations on the vertical milling machine, and the process used to indicate a vise, the apprentice will adjust the milling machine head perpendicular to the table within +/- .001 inch, and indicate a vise maintaining parallelism and perpendicularity measurement of .002 inch over 4.5 inches.

g. Given instruction/demonstration on the proper set-up and procedures used to perform the squaring up operation, the apprentice will square up six primary surfaces of a raw cut block within the tolerance of ± .002 inch maintaining parallelism and perpendicularity measurement with a TIR of .002 inch over 4.5 inches.

h. Given raw material, process plan, print, and hand, precision, and cutting tools, as well as access to an appropriate vertical milling machine and its accessories, produce a part matching the process plan and the blueprint specifications using appropriate trade techniques and speeds and feeds. The part specified should require squaring up from the raw state, have at least one milled slot, require the location of at least two drilled and reamed holes within +/- .005 inch, and have three steps controlled by tolerances of +/-.005 inch.

i. Given raw material, process plan, part print, and hand, precision, and cutting tools, as well as access to an appropriate milling machine and its accessories, produce three bores to specification. The holes will be between ¾ inch and 1-1/2 inches and their locations are to be held within +/-.001 inch and diameters within +/-.0005 inch. One hole is to be counterbored to a decimal depth holding within +/-.002 inch and counterbore diameter within +/-.005 inch.

j. Given raw material, process plan, part print, and hand, precision, and cutting tools, as well as access to an appropriate milling machine and its accessories, produce a part matching the process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified would require milling two keyseats whose characteristics match the ANSI B17.1 keys and keyseat standards.

k. Given raw material, process plan, part print, and hand, precision, and cutting tools, as well as access to an appropriate milling machine and its accessories, produce a part matching the process plan and the part print specifications. The part specified will require the milling of three deep slots-two parallel to one another, the third at right angles to the first two.

Related Instruction

The knowledge and skills you will need to pass the ***Manual Milling: Vertical and Horizontal, Level I Machining Skills*** and ***Manual Milling: Vertical and Horizontal, Level II Machining Skills*** credentialing exams are as follows:

Applying the *Machinery's Handbook*: The apprentice must be able to reference and to apply information found in the handbook to solve applied problems. Referencing thread percentage, tap drill diameters, speeds, feeds, and cutting tool parameters are some of the skills required.

Basic Mathematics: The exam will assess basic math knowledge of fraction/decimal conversion, addition and subtraction of decimals, and an understanding of percentage. Processing basic formulas to solve for the given known or another part of the formula is an additional skill required for this module.

Vertical Milling Machine Components: The exam presents questions asking the student to identify components of vertical milling machines. Apprentices must be able to identify essential components, their functions, and basic machine adjustments.

Threads and Tapping: Areas of knowledge include knowledge of basic safety, cutting tool safety, and basic machine maintenance and housekeeping. Apprentices must know some elementary first-aid procedures they can perform on themselves.

Safety Practices: Areas of knowledge include knowledge of basic safety, cutting tool safety, and basic machine maintenance and housekeeping. Apprentices must know some elementary first-aid procedures they can perform on themselves.

Milling Operations Set-up: The apprentice must know the procedure for adjusting the mill head to be perpendicular to the table (tramming). Other areas of importance include centering various details or shapes and the proper procedure for utilizing center-finding tools. The importance of layout lines and machining to the lines as well as the application of the sine bar are included within milling operations set-up.

NIMS Credentials: Levels I and II Machining Skills, Grinding Skills

---

Core Competency

20. Surface Grinding: Grinding Wheel Safety, Level I Machining Skills

NIMS DUTY & PERFORMANCE STANDARD

Duty: Ring test grinding wheels, perform visual safety inspection, mount and dress a grinding wheel in preparation for surface grinding.

Performance Standard: Given a selection of wheels in various conditions, determine which are suitable for use, mount one on the spindle, and dress it in preparations for surface grinding. Include the understanding of the grinding wheel code.

PERFORMANCE STANDARD: (What an apprentice must know and/or do to perform the work competently.)

a. Given instruction/demonstration and reading assignments on grinding wheel selection and the standard wheel marking system, the apprentice will determine the proper wheel selection to perform all grinding tasks from information obtained from the part print and process plan.

b. Given instruction/demonstration and reading assignments, the apprentice will demonstrate the proper procedure used for visual safety inspection of the grinding wheel, and perform a ring testing to determine the wheel's soundness prior to mounting.

c. Given instruction/demonstration and reading assignments, the apprentice will demonstrate the proper procedure used for balancing (where applicable), mounting, and dressing the grinding wheel on the surface grinder to perform required grinding operations.

Related Instruction

The knowledge and skills you will need concerning Grinding Wheel Safety to pass the ***Level I Machining Skills Surface Grinding*** credentialing exam are as follows:

Grinding Safety: Basic shop practices should be applied in grinding operations. Proper housekeeping and cleanup procedures are critical in safe grinding applications. Proper dress and lifting techniques are also important. Grinding wheel safety is the first step in any grinding procedure. The grinding wheel should be checked for cracks and fractures. Proper installation and wheel dressing are also important factors.

Measurement: Grinding is often considered a finishing operation after milling or rough turning. Grinding operations are usually applied in situations where high accuracy is desired. The apprentice must be able to read a micrometer or vernier micrometer (capable of measuring to .0001 inches). Proper application of dial indicators and height gauges is important in measuring ground surfaces of different heights. Comprehension of surface finish specifications and measuring tool selection are essential inspection skills necessary to ensure quality.

Grinding Wheel Dressing: In order to achieve satisfactory surface finishes and to safely use a grinding wheel, the apprentice must understand and apply proper grinding wheel dressing techniques. Knowledge of the types of grinding wheels that can and cannot be dressed with a diamond dresser is essential for safe machining. Understanding the processes of wheel truing and wheel dressing, as well as the effects of a poorly dressed grinding wheel, provides the apprentice with basic troubleshooting knowledge for assessing the root cause of some grinding problems.

Types of Abrasives: Proper identification and application knowledge of the types of abrasives used in grinding operations provides an apprentice with the proper foundation for determining which type of abrasive is the most effective for a given grinding application. The apprentice should know the most common grinding abrasive as well as the hardest natural abrasive.

Pedestal Grinders: The pedestal grinder is a free-standing grinding machine used for among other applications, roughing, snagging castings, and sharpening high-speed lathe tool bits. Guard location and wheel dressing techniques differ for a pedestal grinder when compared to a surface grinder. The type of grinding wheel installed on the pedestal grinder is dependent on the application and the type of material being ground.

Work Holding: Proper work holding and piece part set-up is important in any grinding operation. The apprentice must know how to hold both ferrous and non-ferrous materials. The set-up for grinding angles and radii must be solid and accurate. The apprentice must know the purpose, theory, and proper set-up of magnetic parallels when grinding ferrous materials.

Grinding Machine Components: To intelligently discuss grinding problems, grinding machine problems, and setups, the apprentice must be familiar with the names of the grinding machine components. The spindle nut on the grinder must be turned in the correct direction to either install or remove the grinding wheel from the spindle. Most machines will

have a left-handed thread to self-tighten from the inertia of the grinding wheel. However, some older machines have the nut tightened by rotating in the same direction as the wheel rotation.

Grinding Carbide and Carbide Tooling: Carbide can be grounded by two types of grinding wheel materials. The best abrasive for machining carbide is diamond. However, due to expense, some carbide grinding applications will use a green silicon carbide wheel. The silicon carbide wheel is inferior to diamond. Diamond wheels, if properly trued and dressed, will yield surface finishes that surpass those produced by silicon carbide grinding wheels.

Core Competency

21. Surface Grinding: Horizontal Spindle, Reciprocating Table, Level I Machining Skills

NIMS DUTY & PERFORMANCE STANDARD

Duty: Set-up and operate manual surface grinders. Perform routine surface grinding, location of surfaces, and squaring of surfaces. Perform wheel dressing.

Performance Standard: Given a block squared up on a mill, a process plan, part print, and hand and precision tools, and choice of a grinding wheel, as well as access to a surface grinder and its accessories, dress the wheel, and produce a part matching the process plan and the part print specifications using appropriate trade techniques. The part specified will be in the semi-finished state, having been squared up. Finishing the part will require the precision finishing of the six faces of the block to tolerances common to precision grinding for squareness, size, and surface finish characteristics.

Core Competency

22. Surface Grinding: Horizontal Spindle, Reciprocating Table, Level II Machining Skills

NIMS DUTIES & PERFORMANCE STANDARDS

Duty: Finish Flats to +/-.0005

Grind a block's six faces to finished dimensions having tolerances of +/-.0005 inch and squareness of .0005 inch over 4 inches, and 32 micro inch surface finish. Dress the wheel as necessary.

Performance Standard: Finish Flats to +/-.0005

Given a block squared up on a mill, hardened to 55 to 60 RC, a process plan, part print, and hand, and precision tools, and choice of grinding wheels, as well as access to a surface grinder and its accessories, dress the wheel, produce a part matching the process plan and the part print specifications using appropriate trade techniques. The part specified will be in the semi-finished state, having been squared up. Finishing the part will require the precision finishing of the six faces of the block to tolerances common to precision grinding for squareness, size, and surface finish characteristics.

Duty: Finish Flats at Simple Angles and Grind Contour Radii

Set-up and perform the finish surface grinding of flat surfaces at simple angles with respect to one another. Dress the wheel as necessary.

Performance Standard: Finish Flats at Simple Angles and Grind Contour Radii

Given a block roughed out on a mill, a process plan, part print, and hand, and precision tools, and choice of grinding wheels, as well as access to a surface grinder and its accessories, dress the wheel, grind the specified radii and angled surfaces to a finish matching the process plan and the part print specifications using appropriate trade techniques. The part specified will be in the semi-finished state, having been roughed out. Finishing the part will require the precision finishing of the specified surfaces of the block to tolerances common to precision grinding for squareness, size, and surface finish characteristics.

Duty: Grinding Wheel Preparation and Balancing

Set-up and perform the preparation and balancing of a grinding wheel 14 inches in diameter or greater. Place the wheel into service.

Performance Standard: Grinding Wheel Preparation and Balancing

Given a wheel and appropriate equipment, prepare the wheel to go into service. Mount the wheel. Produce a surface finish of 32 micro-inches or better on a cylinder or flat surface of CRS.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

a. Given instruction/demonstration and reading assignments on grinding wheel selection and the standard wheel marking system, the apprentice will determine the proper wheel selection to perform all grinding tasks from information obtained from the part print and process plan.

b. Given instruction/demonstration and reading assignments, the apprentice will demonstrate the proper procedure used for visual safety inspection of the grinding wheel, and perform a ring testing to determine the wheels soundness prior to mounting.

c. Given instruction/demonstration and reading assignments, the apprentice will demonstrate the proper procedure used for balancing a wheel (14 inches or greater), mounting, and dressing the grinding wheel on the surface grinder to perform required grinding operations.

d. Given instruction/demonstration and reading assignments, the apprentice will demonstrate knowledge of surface grinder safety procedures, and the identification of surface grinder parts and their function.

e. Given instruction/demonstration on the proper selection, mounting, set-up, and usage procedure for necessary work-holding devices on the surface grinder, the apprentice will select, mount, set-up, hold, and align work using work holding devices on the surface grinder to perform the required grinding operations.

f. Given instruction/demonstration, a block squared up on a mill hardened to 55 to 60 RC, a process plan, part print, precision tools, choice of grinding wheels, and access to a surface grinder and its accessories, choose the appropriate wheel, dress a wheel, and produce a part matching the process plan and the part print specifications using the appropriate techniques. Grind a block's six faces to finished dimensions having a tolerance of ± .0005 inches and perpendicularity TIR of .0005 inches over 4 inches holding a surface finish of 32 micro inches or better.

g. Given instruction/demonstration, a block squared up on a surface grinder, a process plan, part print, precision measuring tools, a choice of grinding wheels, and access to a surface grinder and its accessories, set a radius dresser, dress the wheel, grind the specified radii, angled surfaces and slot to a finish matching the process plan and print specifications using appropriate grinding techniques. Use the appropriate work holding devices to grind all surfaces, angles and contours.

h. Given instruction/demonstration, the apprentice will dress and grind an internal or external radius tangent to an angle other than 90° or 0° holding tolerances correlated to the NIMS credentialing print for Machining – Level II Surface Grinding.

Related Instruction

The knowledge and skills you will need to pass the ***Surface Grinding: Horizontal Spindle, Reciprocating Table, Level I and Level II Machining Skills*** credentialing exams are as follows:

Grinding Safety: Basic shop practices should be applied in grinding operations. Proper housekeeping and cleanup procedures are imperative in safe grinding applications. Proper dress and lifting techniques are also important. Grinding wheel safety is the first step in any grinding procedure. The grinding wheel should be checked for cracks and fractures. Proper installation and wheel dressing are also important factors.

Measurement: Grinding is often considered a finishing operation after milling or rough turning. Grinding operations are usually applied in situations where high accuracy is desired. The apprentice must be able to read a micrometer or vernier micrometer (capable of measuring to .0001 inches). Proper application of dial indicators and height gauges is important in measuring ground surfaces of different heights. Comprehension of surface finish specifications and measuring tool selection are essential inspection skills necessary to ensure quality.

Grinding Wheel Dressing: In order to achieve satisfactory surface finishes and to safely use a grinding wheel, the apprentice must understand and apply proper grinding wheel dressing techniques. Knowledge of the types of grinding wheels that can and cannot be dressed with a diamond dresser is essential for safe machining. Understanding the process of wheel truing and wheel dressing and the effects of a poorly dressed grinding wheel provide the apprentice with basic troubleshooting knowledge for assessing the root cause of some grinding problems.

Types of Abrasives: Proper identification and application knowledge of the types of abrasives used in grinding operations provides an apprentice with the proper foundation for determining which type of abrasive is the most effective for a given grinding application. The apprentice should know the most common grinding abrasive as well as the hardest natural abrasive.

Pedestal Grinder: The pedestal grinder is a free-standing grinding machine used for among other applications, roughing, snagging castings, and sharpening high-speed lathe tool bits. Guard location and wheel dressing techniques differ for a pedestal grinder when compared to a surface grinder. The type of grinding wheel installed on the pedestal grinder is dependent on the application and the type of material being ground.

Work Holding: Proper work holding and piece part set-up is important in any grinding operation. The apprentice must know how to hold both ferrous and non-ferrous materials. The set-up for grinding angles and radii must be solid and accurate. The apprentice must know the purpose, theory, and proper set-up of magnetic parallels when grinding ferrous materials.

Grinding Machine Components: To intelligently discuss grinding problems, grinding machine problems, and setups, the apprentice must be familiar with the names of the grinding machine components. The spindle nut on the grinder must be turned in the correct direction to either install or remove the grinding wheel from the spindle. Most machines will have a left-handed thread to self-tighten from the inertia of the grinding wheel. However, some older machines have the nut tightened by rotating in the same direction as the wheel.

Grinding Carbide and Carbide Tooling: Carbide can be ground by two types of grinding wheel material. The best abrasive for machining carbide is diamond. However, due to expense, some carbide grinding applications will use a green silicon carbide wheel. The silicon carbide wheel is inferior to diamond. Diamond wheels, if properly trued and dressed, will yield surface finishes that surpass surface finishes produced by silicon carbide grinding wheels.

NIMS CREDENTIAL: Level I CNC Milling and / or CNC Turning

Core Competency

23. CNC Programming - Milling

NIMS DUTY & PERFORMANCE STANDARD

Duty: Using the principles of Cartesian coordinates, develop a program for the manufacture of a simple part.

Performance Standard: Given a computer and a basic CNC software program, and a blueprint for part comparison, apply the principles of three dimensional coordinate planes in the development of a simple program for the production of the part on a CNC milling machine.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

a. The apprentice will be able to describe the functions and use of basic G and M codes.

b. The apprentice will be able to identify coordinates on a blueprint with respect to an origin.

c. The apprentice will be able to implement linear interpolation into a program to cut straight lines between two points.

d. The apprentice will be able to implement circular interpolation into a program to cut true arcs and circles, using I & J (arc vector) and R (radium value) methods.

e. The apprentice will be able to write a program using the appropriate format for a particular machine control, and work from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc., that will be used.

CNC Programming - Turning

NIMS DUTY & PERFORMANCE STANDARD

Duty: Using the principles of Cartesian coordinates develop a program for the manufacture of a simple part.

Performance Standard: Given a computer and a basic CNC software program, and a blueprint for part comparison, apply the principles of two-dimensional coordinate planes in the development of a simple program for the production of the part on a CNC lathe or CNC turning center.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

a. The apprentice will be able to describe the functions and use of basic G and M codes.

b. The apprentice will be able to identify coordinates on a blueprint with respect to an origin.

c. The apprentice will be able to implement linear interpolation into a program to cut straight lines between two points.

d. The apprentice will be able to implement circular interpolation into a program to cut true arcs and circles, using I & J (arc vector) and R (radius value) methods.

e. The apprentice will be able to write a program using the appropriate format for a particular machine control, and work from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc., that will be used.

Core Competency

24. CNC: Write a Simple CNC Milling Program and Review Tool Path

NIMS DUTY & PERFORMANCE STANDARD

Duty: Using a computer and editor software, write simple CNC programs using M and G codes from the *Machinery's Handbook*. Simple programs are single plane, cutter centerline, linear and circular interpolation, and single cutter, with no canned cycles as specified on the print.

Performance Standard: Given a part print with the tool path shown, and computer with editor software, write a program, including speeds and feeds, to drive an end mill through a continuous path around three sides of a part requiring the development of a linear interpolation tool path as well as circular interpolation. Store the program on computer media.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

a. The apprentice will be able to describe the functions and use of basic G and M codes.

b. The apprentice will be able to identify coordinates on a blueprint with respect to an origin.

c. The apprentice will be able to calculate and implement speeds and feeds for proper tool life and surface finish.

d. The apprentice will be able to implement linear interpolation into a program to cut straight lines between two points.

e. The apprentice will be able to implement circular interpolation into a program to cut straight lines between two points.

f. The apprentice will be able to write a program using the appropriate format for a particular machine control, and work from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc., that will be used.

CNC: Write a Simple CNC Turning Program and Review Tool Path

NIMS DUTY & PERFORMANCE STANDARD

Duty: Using a computer and editor software write simple CNC programs using M and G codes from the *Machinery's Handbook*. Simple programs are single plane, cutter centerline, linear and circular interpolation, and single cutter, with no canned cycles as specified on the print.

Performance Standard: Given a part print with the tool path shown, and computer with editor software, write a program, including speeds and feeds, to drive a cutting tool through a continuous path following the geometry of a part requiring the development of a linear interpolation tool path as well as circular interpolation. Store the program on computer media.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

a. The apprentice will be able to describe the functions and use of basic G and M codes.

b. The apprentice will be able to identify coordinates on a blueprint with respect to an origin.

c. The apprentice will be able to calculate and implement speeds and feeds for proper tool life and surface finish.

d. The apprentice will be able to implement linear interpolation into a program to cut straight lines between two points.

e. The apprentice will be able to implement circular interpolation into a program to cut true arcs and circles, using the I & J (arc vector) and R (radius value) methods.

f. The apprentice will be able to write a program using the appropriate format for a particular machine control, and work from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc., that will be used.

Core Competency

25. CNC: Operate a CNC Milling Machine

NIMS DUTY & PERFORMANCE STANDARD

Duty: Operate a CNC Milling Machine

Performance Standard: Given a CNC mill, create a qualified CNC program, set-up and operate the mill, change tool values as necessary, and replace and qualify tooling as necessary.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

a. The apprentice will be able to describe the functions and use of basic G and M codes.

b. The apprentice will be able to identify coordinates on a blueprint with respect to an origin.

c. The apprentice will be able to calculate and implement speeds and feeds for proper tool life and surface finish.

d. The apprentice will be able to write a program using the appropriate format for a particular machine control, and work from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc., that will be used.

e. The apprentice will be able to install and qualify the required tooling for the program.

f. The apprentice will be able to mount, locate, and set the origin of the work piece on a CNC milling machine.

g. The apprentice will be able to load a program, create a DNC-link, or enter a program via control keyboard into a CNC milling machine control.

h. The apprentice will be able to safely execute a program for its first run (debugging).

CNC: Operate a CNC Lathe

NIMS DUTY & PERFORMANCE STANDARD

Duty: Operate a CNC Lathe

Performance Standard: Given a CNC lathe create a qualified CNC program, set-up and operate the lathe, change tool values as necessary, and replace and qualify tooling as necessary.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

a. The apprentice will be able to describe the functions and use of basic G and M codes.

b. The apprentice will be able to identify coordinates on a blueprint with respect to an origin.

c. The apprentice will be able to calculate and implement speeds and feeds for proper tool life and surface finish.

d. The apprentice will be able to write a program using the appropriate format for a particular machine control, and work from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc., that will be used.

e. The apprentice will be able to install and qualify the required tooling for the program.

f. The apprentice will be able to mount, locate, and set the origin of the workpiece on a CNC lathe.

g. The apprentice will be able to load a program, create a DNC-link, or enter a program via control keyboard into a CNC lathe control.

h. The apprentice will be able to safely execute a program for its first run (debugging).

CORE COMPETENCIES ALIGNED WITH ALL MACHINING CREDENTIALS

Core Competency

26. General Housekeeping and Maintenance

NIMS DUTY & PERFORMANCE STANDARD

Duty: Keep the duty station clean and safe for work. Keep the tools, workbenches, and manual equipment clean, maintained, and safe for work.

Performance Standard: Given maintenance, cleaning, and housekeeping checklists, as well as verbal instructions, clean, maintain, and respond appropriately to safety hazards on all benchwork tools and conventional and CNC machine tools. Maintain the cleanliness of the general work area.

Core Competency

27. Preventative Maintenance - Machine Tools

NIMS DUTY & PERFORMANCE STANDARD

Duty: Inspect and assess the general condition of an assigned machine tool. Make routine adjustments as necessary and as authorized. Report problems to supervision which are beyond the scope of authority. Carry out daily, weekly, and/or monthly routine upkeep chores cited on checklists for a given machine tool.

Performance Standard: Given the preventive maintenance procedures and schedules for a given machine tool, as well as sufficient instruction and experience to recognize maintenance problems, carry out routine maintenance, report problems which are beyond the scope of authority, and fill out the history forms for tracking maintenance.

28. Tooling Maintenance

NIMS DUTY & PERFORMANCE STANDARD

Duty: Inspect and assess the condition of tooling. Refurbish tooling where appropriate. Refer tooling for repair or regrind where appropriate.

Performance Standard: Given samples of tooling in various conditions, diagnose the tooling and take the correct steps to put the tooling back in service. The sample tooling should include turning, milling, and drilling tools. These tools should be both insert tooling as well as conventional tooling. The apprentice must demonstrate the offhand grinding of a drill between the diameter of .125 inch and 1.000 inch. The offhand regrinding of a turning tool and the correct rotation and replacement of inserts in an insert style milling cutter body must be demonstrated. The apprentice must demonstrate the ability to recognize when a cutter should be referred to a tool and cutter grinder.

PERFORMANCE OBJECTIVES: (What an apprentice must know and/or do to perform the work competently.)

General Housekeeping and Maintenance

Given maintenance, cleaning, and housekeeping checklist as well as verbal instructions, clean, maintain, and respond appropriately to safety hazards on all benchwork tools and conventional and CNC machine tools. Maintain the cleanliness of the general work area.

Preventative Maintenance - Machine Tools

Given a specific machine tool, the learner will locate, check, and fill all applicable lubrication reservoirs, check for proper oil pressure, and check that all lubrication points are functioning properly. Check the general condition of the equipment and make routine adjustments as stated in the maintenance schedule.

Tooling Maintenance

a. Diagnose tooling in various conditions and take the correct steps to put the tooling back in service.
b. Perform cutter-sharpening operations.
c. Understand insert identification nomenclature and index or change inserts.